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PLC Based Automatic Climate Control, Egg Collection and Solid Waste Management System for Poultry Farming

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ABSTRACT

This project presents a PLC-based automated system designed to enhance the efficiency of poultry farming by integrating climate control, egg collection, and solid waste management. The system employs a Programmable Logic Controller (PLC) to monitor and control environmental parameters such as temperature, humidity, andventilation, maintaining ideal circumstances for the health of poultry andegg production. An automated egg collection mechanism utilizes conveyors to transport eggs to a central collection area, reducing manual labor and the risk of breakage. Additionally, a solid waste management system efficiently collects and disposes of waste through a scraper and conveyor mechanism, improving farm hygiene and promoting sustainability by allowing waste to be used for composting or biogas generation. This approach aims to reduce human intervention, optimize resource usage, and improve overall productivity. The system provides a scalable solution for modern poultry farming, enhancing operational efficiency while maintaining animal welfare and environmental cleanliness. By automating these key processes, the proposed system offers a sustainable, cost-effective, and reliable solution for large-scale poultry operations.

Keywords: PLC-based Automation, Poultry Farming, Control Systems, Egg Collection Automation, Solid Waste Management, Environment Monitoring, Temperature and Humidity Control, Cost-effective Farming Solutions.

INTRODUCTION

The rapid advancement of automation technologies has revolutionized various industries, including agriculture and livestock farming. Among these innovations, Programmable Logic Controller (PLC)-based systems have emerged as a game-changing solution for poultry farming. This approach integrates automated control, monitoring, and management of essential processes, ensuring efficiency, productivity, and sustainability in poultry farming operations.

PLC-based automatic poultry farming systems use cutting-edge technology to address key challenges faced by modern poultry farms. The need for precise and consistent control over feeding schedules, environmental conditions, water supply, and waste management has driven the adoption of automated solutions. By employing PLC systems, poultry farmers can manage their operations with minimal human intervention while achieving higher levels of accuracy and reliability.

One of the most significant benefits of PLC-based systems is their ability to automate feeding processes. Traditional manual feeding methods are time-consuming and prone to inefficiencies, such as overfeeding or underfeeding. PLCs control automated feed dispensers, ensuring the right amount of feed is distributed to poultry at the appropriate times.

This not only reduces feed wastage but also promotes uniform growth and health among the flock. Maintaining an optimal environment is another critical aspect of poultry farming that is enhanced by PLC technology. Factors such as temperature, humidity, and ventilation directly impact the health and productivity of poultry. PLCs regulate these parameters through sensors and actuators that control devices like fans, heaters, and humidifiers. The system can adjust environmental conditions in real time based on pre-set thresholds, creating a stable and comfortable living environment for the poultry. Water supply is another essential component of poultry farming those benefits from PLC automation. Clean and consistent water availability is vital for poultry health and growth. PLC systems monitor water levels and quality, ensuring uninterrupted supply while reducing wastage. Automated wagering systems controlled by PLCs also allow farmers to track water consumption patterns, helping identify potential issues early.

Automation in poultry farming, using Programmable Logic Controllers (PLCs), improves efficiency by automating critical processes like climate control, egg collection, and waste management. PLC-based systems maintain optimal temperature, humidity, and ventilation, promoting better bird health and productivity. Automated egg collection reduces breakage and labour, while waste management systems ensure cleanliness and sustainability, addressing

environmental concerns.These technologies help scale operations, reduce manual labour, and enhance farm productivity, health, and hygiene.

LITERATURE SURVEY

Chickens are the most common and widely raised poultry birds and thus nurturing these birds for mass demand has become one of the most flourishing and traditional business initiatives. Some chickens take less time to become mature and generate profit. In order to get a satisfactory profit out of the farming business, it is vital to maintaining the inner environment of the farm, which requires proper temperature, optimum light intensity and well-maintained hygiene [1] Proper hygiene and care can minimize diseases and illness in poultry. If a machine can automatically control all the crucial factors and other environmental factors of a poultry farm, it may reduce the overall cost in the long run by simplifying the control and maintenance of the farmers. Smart or automated poultry farm is one of the most splendid creations of modern technologies which are now highly accepted in different parts of the world [2]

The temperature, water level, smoke, gas, and food dispensing may all be monitored with a wireless sensor network and GPRS. All data is controlled and monitored by a Raspberry Pi. GPRS is used for sending the data, and a webpage contains an extensive history of the poultry farm together with the current state of the environment. Intriguingly, they discovered that utilizing a smart poultry nursery can increase production by lowering the mortality rate and accelerate it to reach the target 2.0 kg in 7 weeks as opposed to 9 weeks. Furthermore, they were able to achieve each 2 kg weight with less feed, saving almost 50% on feed costs, based on their results when comparing smart poultry procedures to conventional farms. [3]

In Brunei, where most farms are operated by hand, there is an IoT-based smart poultry farm. For controlling temperature, humidity, air quality, lighting, ventilation, and food feeding, their system uses an Arduino microcontroller in conjunction with a number of sensors. In addition to the web interface to monitor those characteristics, their designed system can automatically send alarm notifications to the user via SMS, email, and WhatsApp.[4]

Installation of a small-scale chicken farm control system following farm modelling and simulation. They concentrate on temperature, light humidity, and gas regulation. Their Arduino-based device was tested on a small farm with almost 100 quails. [5]

Creation of an intelligent chicken and poultry farm with an Arduino real-time operating system (RTOS). According to their experimental findings, RTOS on Arduino outperforms non-RTOS on Arduino. Automation was included in water distribution and feeding systems in addition to the environment.An Arduino-based sensor is used to detect changes in water level, and a flow sensor is used to find the leaks [6]

An automatic chicken feeder for Malaysia's poultry industry. Their machine partially automates the feeding method and reduces labor work. The Arduino Uno serves as the machine's primary controller. [7]

In addition to gathering sensing data like temperature, humidity, and light intensity as provided by the system, more sophisticated and intricate schemes use algorithms for image processing to detect population density. They also integrate wireless sensor and portable networks with a renowned sensor integration system toward the cloud offloading scalability work via a hybrid architecture used for data analytics and then promptly make decisions to modify the behavior of the environment accordingly. To determine population density, methods for classification of images are used. [8] Using GSM technology found in mobile phones, remote surveillance has been introduced to the farm. However, the automated conversion of light system was only used to determine how many people were moving around the room. This did not allow for stable lighting for the poultry when it was needed, and it used a sprinkler system to boost humidity, which, if used on a poultry farm, would result in water droplets appearing on the chicken. [9]

To keep track of any changes to the owner's farm, network data is transferred to an online database via an intermediary program and then accessible online through web analytic tools. Monitoring and managing the environment receives more emphasis than monitoring and giving chick care, according to the prior assessment of published publications. We plan to address the environment and chicks in our work. [10]

RELAVENCE:
Automation in agriculture, particularly in poultry farming, has gained significant relevance due to the increasing global demand for food and the need for sustainable farming practices. Traditional farming methods, while effective on smaller scales, struggle to meet the efficiency, productivity, and hygiene standards required in large-scale operations. This is particularly true in poultry farming, where factors like climate control, egg collection, and waste management have a direct impact on both the well-being of the birds and the profitability of the farm.

i. Improved Productivity and Efficiency In modern poultry farming, maintaining consistent environmental conditions such as temperature, humidity, and ventilation is critical to ensuring optimal egg production and poultry health. Manual monitoring and control are not only time-consuming but prone to human error. Automation through PLCs offers real-time monitoring and control of these variables, significantly improving efficiency and ensuring that optimal conditions are maintained consistently. Additionally, automating egg collection reduces labor costs and the risk of breakage, enhancing overall productivity.

ii. Health and Welfare of Poultry Poultry birds are highly sensitive to changes in environmental conditions. Poorly managed temperature, humidity, or air quality can result in stress, diseases, and reduced egg production. Byautomating climate control, the system ensures that thepoultry house remains within idealenvironmental parameters, promoting the health and welfare of the birds. This is particularly important as consumer awareness of animal welfare grows, and regulations around humane farming practices become stricter.

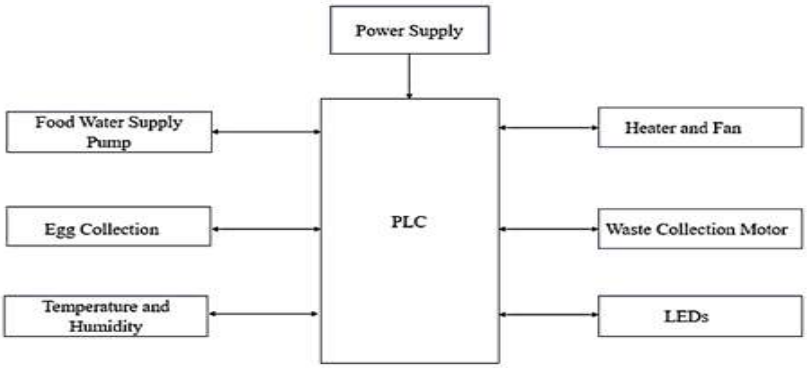
iii. Sustainability and Environmental Impact Solid waste management is a critical aspect of poultry farming, with improper.disposal leading to pollution, disease outbreaks, and other environmentalconcerns.Automation helps manage waste more efficiently, reducing the risk of contamination and making it easier to process waste for composting or biogas generation. This promotes sustainable practices by turning waste into valuable resources such as organic fertilizers or renewable energy

iv. Labor Reduction and Cost Efficiency Poultry farming is traditionally labor-intensive, particularly in large farms where climate management, egg collection, and waste disposal are ongoing tasks. By automating these processes, the need for manual labor is significantly reduced, lowering labor costs and minimizing human error. This makes large-scale poultry farming more economically viable while ensuring that operational efficiency remains high.

SYSTEM DEVELOPMENT

BLOCK DIAGRAM: -

A **Programmable Logic Controller (PLC)** is a rugged computer used in poultry farming to automate key operations like feeding, watering, temperature control, egg collection, and waste management. PLCs improve efficiency by reducing manual labour, ensuring precise environmental conditions for poultry health, and offering real-time monitoring. By using sensors and automated systems, PLCs optimize farm operations, reduce costs, and enhance productivity while ensuring the well-being of the poultry



Block diagram of Poultry Automation system using PLC

Power Supply:

The power supply ensures all components, like sensors and the PLC, receive the required electricity. Backup sources like UPS or generators maintain operations during power outages, and the system must be protected from surges and short circuits.

PLC (Programmable Logic Controller):

The PLC automates farm processes by receiving sensor inputs and sending commands to actuators. It controls feeding, water distribution, temperature, humidity, egg collection, waste removal, and fan/heater management. It should be robust and capable of real-time data handling.

Food and Water Supply Pumps: The PLC manages pumps to deliver food and water based on set schedules or sensor readings, ensuring continuous supply without manual
intervention. The pumps must be durable and reliable, and sensors monitor the supply levels.

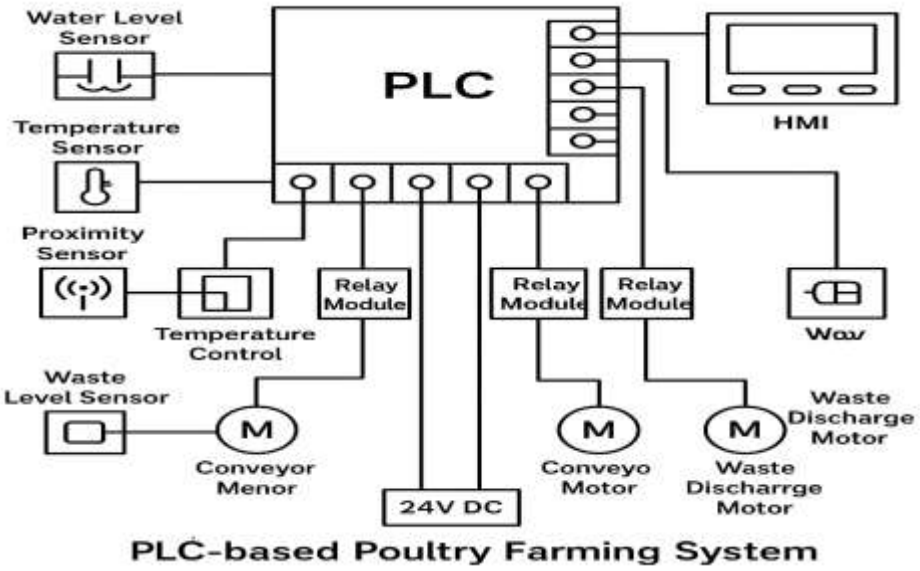
Egg Collection System:
The PLC coordinates egg collection using conveyors, sensors, and bins, ensuring eggs are collected efficiently without damage and adjusting based on bin capacity.

Temperature and Humidity Control:
The PLC regulates temperature and humidity by activating heating, cooling, and ventilation systems based on sensor data, ensuring a comfortable environment for the poultry to prevent stress or disease.

Waste Collection Motor:
The PLC operates motors and conveyors to collect and dispose of waste, maintaining hygiene and preventing disease. The system must handle both solid and liquid waste and be durable for continuous use.

Heaters and Fans:
The PLC controls heaters and fans to maintain ideal temperature and airflow, ensuring the poultry's comfort andhealth by responding to temperature fluctuations and environmental changes.

CIRCUIT DIAGRAM:



Circuit Diagram of PLC Poultry Farming

The PLC-based Poultry Farming System automates essential farm operations using sensors, motors, and a PLC controller. The water level sensor monitors water supply, triggering refilling when low. The temperature Sensor regulates climate conditions by activating cooling or heating systems. The proximity sensor detects poultry presence and controls the conveyor motor to dispense food. The waste level sensor detects accumulated waste, activating the waste discharge Motor for cleaning. The PLC processes sensor inputs and controls outputs via relay modules. The HMI allows users to monitor and manually control the system. The entire system operates on a 24V DC power supply, ensuring efficient and automated poultry farm management.ThePLC-based Poultry Farming System uses various components to automate farm operations efficiently:

Water Level Sensor: This sensor constantly monitors the water supply level in the system. When it detects a low water level, it triggers the refilling process to maintain an adequate water supply for the poultry.

Temperature Sensor: It tracks the environmental temperature inside the poultry farm. When the temperature exceeds or falls below the desired range, it activates cooling or heating systems to regulate the climate, ensuring a comfortable environment for the birds.

Proximity Sensor: This sensor detects the presence of poultry in specific areas of the farm, such as feeding zones. It controls the conveyor motor to dispense food automatically when poultry is detected, ensuring they are fed properly.
Waste Level Sensor: Positioned in waste collection areas, this sensor monitors the accumulation of waste. When it detects that the waste level has reached a certain point, it activates the Waste Discharge Motor to clean the system by

removing the waste. Relay Modules: These modules are used by the PLC to control high-power devices like motors or pumps. They act as intermediaries, switching on/off based on the PLC's signals.

HMI (Human-Machine Interface): The HMI provides a user-friendly interface for operators to monitor system performance. It allows manual control of certain functions, displays sensor data, and provides alerts when system parameters fall outside predefined thresholds.

24V DC Power Supply: The entire system operates on a 24V DC power supply, which ensures a steady and safe power flow for all the components, making the system energy-efficient and reliable.

Programmable Logic Controller (PLC):

Swastik (PLC) :
An industrial automation and software development company offering products and services in industrial reliability, condition monitoring, automation solutions, test and measurement equipment andenergy-saving applications.Authorized channel partners for Crompton Greaves, Emotion providing AC drives, PLCs, HMIs, and related services for automation systems across various industries. Manufactures and exports automation products such as SRC controllers, temperature scanners, process controllers, and PLC HMIs. A Programmable Logic Controller, or PLC, is a ruggedized computer used for industrial automation. These controllers can automate a specific process, machine function, or even an entire production line. The PLC receives information from connected sensors or input devices, processes the data, and triggers outputs based on pre-programmed parameters. Depending on the inputs and outputs, a PLC can monitor and record run-time data such as machine productivity or operating temperature.

AUTOMATION SYSTEM

Convers
Temperature Control
Humidity Control

1.Convers

A. Egg Collection Conveyor

Working:
The conveyor system automatically collects eggs from laying areas, minimizing human intervention. Sensors detect the presence of eggs, and the conveyor transports them to collection points for easy harvesting.

Specifications:
Speed: Adjustable (typically 0.5 to 3 meters per minute).
Power Supply: 24V DC or 110V AC, depending on the system.
Material: Corrosion-resistant, food- grade materials like stainless steel.

Applications:
Used in egg farms to streamline egg collection, reduce breakage, and improve operational efficiency. Also applicable in other automated sorting systems in agriculture.

B. Food Management Conveyor:

Working:
The conveyor transports feed to different sections of the farm. Proximity sensors detect poultry presence, activating the system to dispense food as needed, ensuring timely and adequate feeding.

Specifications:
Speed: Adjustable speed to control food flow (typically 1 to 5 meters per minute).
Power Supply: 24V DC or 220V AC.
Material: Durable, food-safe material such as polyethylene or stainless steel.

Applications:
Used for feeding systems in poultry farms, ensuring consistent and efficient food delivery to birds.
Also used in food processing industries for material handling.

C. Waste Management Conveyor:

Working:
The conveyor moves waste material (feathers, litter, etc.) from poultry areas to waste collection points. Waste level sensors monitor accumulation, triggering the system to activate and transport waste to designated disposal areas.

Specifications:
Capacity: Varies based on the farm size (up to 50 kg/min).
Power Supply: Typically, 24V DC or 110V AC.
Material: Tough, resistant to wear and tear, made from steel or heavy-duty plastic.

Applications:
Used in poultry farms to keep environments clean by automatically managing waste disposal. Can also be used in other agricultural waste management systems.

2. Temperature Control

Working:
Temperature sensors continuously monitor the temperature inside the poultry farm. If the temperature deviates from the optimal range, the **PLC** activates the **heater** to raise the temperature or deactivates the system if the desired temperature is reached.

Heater: Used to warm the poultry house when the temperature falls below the set point, ensuring a comfortable environment for the birds, especially in colder weather.

Specifications:
Temperature Range: Typically, 5°C to 45°C.
Power Supply: 220V AC or 24V DC, depending on the system.
Material: Stainless steel or other heat-resistant materials.
Control: Automated through the PLC with setpoint adjustment via HMI.

Applications:
Essential in maintaining an ideal climate for poultry farming, preventing temperature stress, and promoting healthy bird growth. Also used in industrial applications requiring precise temperature control, such as greenhouses or cold storage.

3.Humidity Control
Working:
Humidity sensors continuously monitor the relative humidity in the poultry house. If the humidity level drops below the optimal range, the **PLC** activates the **fogger** to add moisture to the air, raising the humidity level to a desired range. If the humidity is too high, the system may deactivate the fogger or activate ventilation systems to reduc moisture.

Fogger:
A fogger system creates a fine mist that increases the humidity in the poultry house, ensuring proper moisture levels are maintained for the birds' health, especially in dry climates or during cold weather when heating can dry the air.

Specifications:
Humidity Range: Typically, 40% to 80% RH.
Power Supply: 24V DC or 110V/220V AC, depending on the fogger system.
Spray Capacity: Varies based on the size of the system (typically 5-10 liters/hour).
Control: Automated via PLC based on sensor feedback.

Applications: Used in poultry farms to regulate moisture levels, preventing issues such as respiratory stress, feather picking, and dehydration. Also applied in greenhouses, warehouses, and other environments where humidity control is crucial for product quality and safety.

CONCLUSION

Poultry farming, a vital industry for egg and meat production, faces increasing challenges as manual labour struggles to keep up with the demands of managing environmental conditions, egg collection, and waste disposal. As farms expand, these inefficiencies intensify, negatively affecting poultry health and overall production. Automation through

Programmable Logic Controllers (PLCs) offers an effective solution. By automating key processes such as climate control, egg collection, and waste management, this project aims to enhance farm productivity, improve bird health, and promote sustainability, all while significantly reducing the need for manual labour. Through intelligent automation, the system can adapt to changing conditions, ensuring optimal environments for poultry and streamlining essential tasks, ultimately improving efficiency and production rates.

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